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STUDIES OF ELECTRONIC AND OPTOELECTRONIC PROPERTIES OF
SUPERLATTICES(U) STATE UNIV OF NEW YORK AT BUFFALO DEPT
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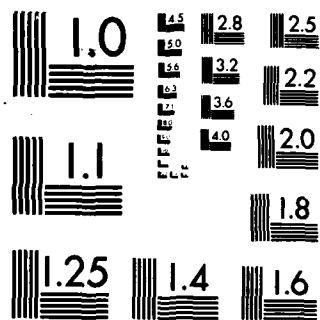
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ANNUAL REPORT

Title: Studies of Electronic and Optoelectronic Properties of Superlattices

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84-K-0387

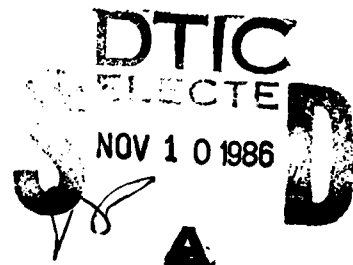
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Period: October 1, 1985 - September 30, 1986

Date: September 29, 1986

Report:

Overview: (i) Unusual Event



One of my colleagues, Dr. Smrcka, received recently a Presidential award in Czechoslovakia for his contributions to transport theory in 2D electron Systems. Some of his recent works were coauthored with me, and I was invited to the Czechoslovak Academy of Sciences for one week during August, 1986.

(ii) Accomplishments

During the one year period, I completed 11 articles, including 6 published, 3 accepted for publication, and 2 in the process of publication. Among these, particularly important accomplishments are as follows:

(a) Fractional Quantized Hall Effect;

An exact and explicit evaluation of the ground state energy of the Laughlin state for the fractional quantized Hall effect was accomplished and a possibility for a broken symmetry was suggested. Since the FQHE has been associated with the formation of a new liquid-like state which has energy lower than a Wigner lattice, such a calculation is very important in contrast to Monte Carlo and other approximate calculations. For a phase transition into such a new state, a broken symmetry has been sought by Thouless and others.

(b) Integral Quantized Hall Effect

Based on a self-consistent memory functional approach, a direct evaluation of the Hall conductivity was made and the appearance of quantized plateaus was shown.

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(c) Magnetoconductivity

A new theory of the magnetoconductivity of 2D electron systems was constructed, and its density and field dependences were explained. Our theoretical results (Fig. 1) agree with the data of Fang, Fowler and Hartstein (inset in Fig. 1) extremely well, thereby the appearance of a broad maximum and its shift with magnetic field were explained.

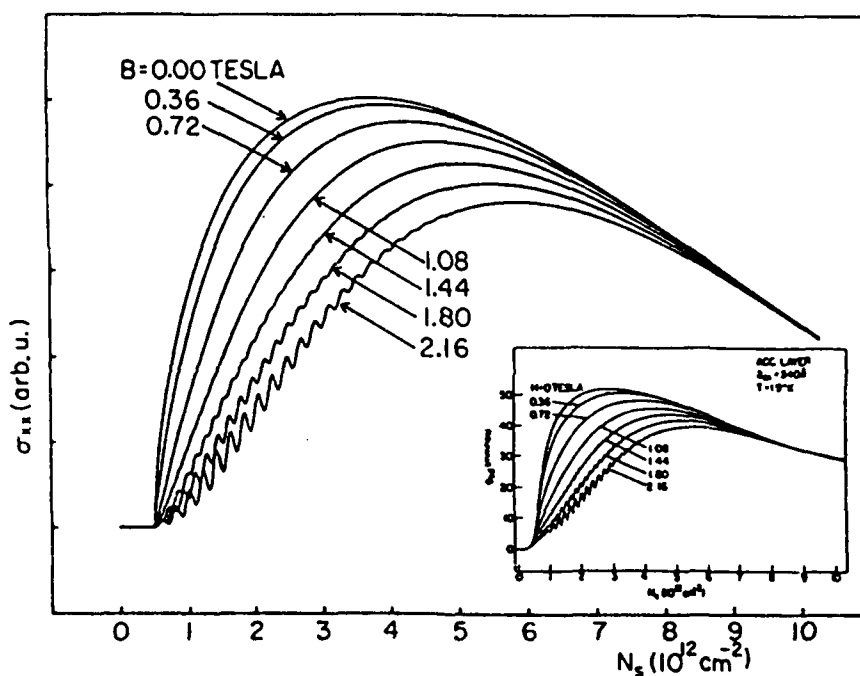


Fig. 1 Magnetoconductivity of a Si accumulation layer at 1.9K.

(d) Sound Propagation in He Films

Phonon decay and sound propagation in various modes in helium films were investigated. It was shown that the second sound velocity is $1/2^{1/2}$ times the first sound velocity in the low-temperature and low-frequency limit. In the bulk case, it is $1/3^{1/2}$ times the first sound velocity.

(e) Size Quantization Effect

Two new theories have been constructed based on soft- and hard-wall models. For the first time, it was shown that size quantization causes quantum oscillations in conductivity. This agrees with the recent observation by Skocpol et al [Surf. Sci. 142, 14 (1984)]. Figure 2 illustrates our main results in which the upper curves correspond to 140 nm and lower curves to 110nm width Si inversion layers.

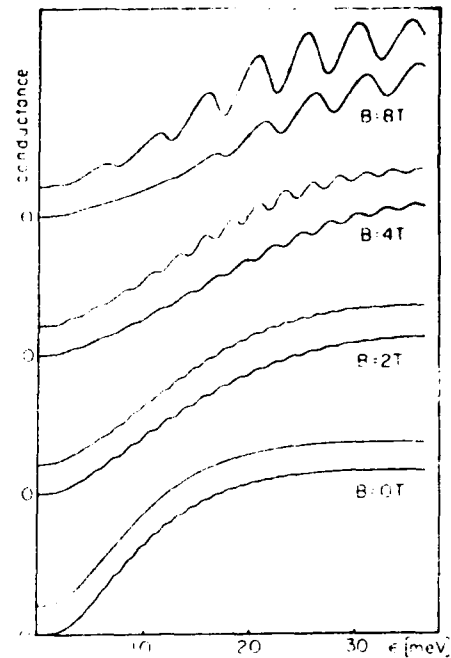


Fig. 2 Theoretical conductance, showing width effects.

Articles Completed

(a) Articles Submitted for Publication

1. A. Isihara, K. Ebina, L. Smrcka and H. Havlova, Magnetic Crossover in Narrow 2D Systems, "Applications of High Magnetic Fields in Semiconductor Phys.", Proc. Wurzburg Conf.
2. A. Isihara and K. Ebina, Energy Levels and Density of States of Narrow 2D Systems, Phys. Rev., to be submitted.

(b) Papers Accepted for Publication

3. A. Isihara and L. Smrcka, Density and Magnetic Field Dependences of the Conductivity of Two-Dimens. Elec. Sys., J. Phys. C: Solid State Phys. Accepted for publication.
4. A. Isihara and L. Smrcka, Width Effect on the Magnetoelectricity of 2D Elec. Sys., Solid State Commun., Accepted for publication.

5. H. G. Oh, C. I. Um, W. H. Kahang and A. Isihara, First and Second Sound in Helium Films, Phys. Rev. B. Accepted for publication.

(c) Papers Published

6. A. Isihara, Quantized Hall Effect in Two-Dimen. Elec. Sys., J. Phys. C: Solid State Phys. 18, 5835 (1985).

7. L. Smrcka and A. Isihara, Carrier and Field Dependences of the Magneto-conductance of Two-dimen. Elec. Sys., Solid State Commun. 57, 259 (1986).

8. A. Isihara, Quantized Plateaus of the Hall Conductance of 2D Electron Sys., Proc. Internat. Conf. on Elec. Prop. of 2D Sys. [Surf. Sci. 170, 267 (1986)].

9. C. I. Um, H. G. Oh, W. H. Kahang and A. Isihara, Phonon Decay in Two-dimen. Liquid ^4He , Phys. Rev. B33, 7550 (1986).

10. K. Takano and A. Isihara, Ground State for the Fractional Quantized Hall Effect, Phys. Rev. Rapid Commun. B34, 1399 (1986).

11. L. Smrcka, H. Havlova and A. Isihara, Quantum Oscillations in Two-dimen. Elec. Sys. with Finite Width, J. Phys. C: Solid State Phys. Lett. 19, L475 (1986).

Scientific Presentations and Meetings Attended

The P. I. presented a new theory of the integral quantized Hall effect at the International Conference in Kyoto. In this connection, he was invited to give colloquium talks at the University of Tokyo, University of Tsukuba, Gakushuin University, Fuji-Xerox Research Center, and Hitachi Central Research Laboratory. Also a special Symposium was organized on liquid Helium at Tsukuba University where he gave an invited talk. He gave also colloquium and seminar talks at the University of Minnesota.

During August, 1986, the P. I. was invited to the Czechoslovak Academy of Sciences in Praha to interact with Dr. Smrcka and others and also to give an invited talk on "Correlation Effects in 2D Electron Systems". Taking this opportunity, the P. I. was able to attend the International Conference on the Applications of High Magnetic Fields in Semiconductor Physics held in Wurzburg, Germany, where he presented a new theory for the effects of size quantization on conductivity. Dr. Smrcka presented a paper on related subjects including the Hall conductivity at the 24th International Conference on Low Temperature Physics held in Tbilisi, USSR, in September, 1986. This paper is coauthored with Havlova and myself.

Books Published and Patent Filed: None

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